

**FINAL REPORT FOR**  
**AFOSR GRANT**  
**No. F49620-99-1-0106**

**“Equipment for Fabrication of Microdischarge Devices and Arrays”**

Prepared for

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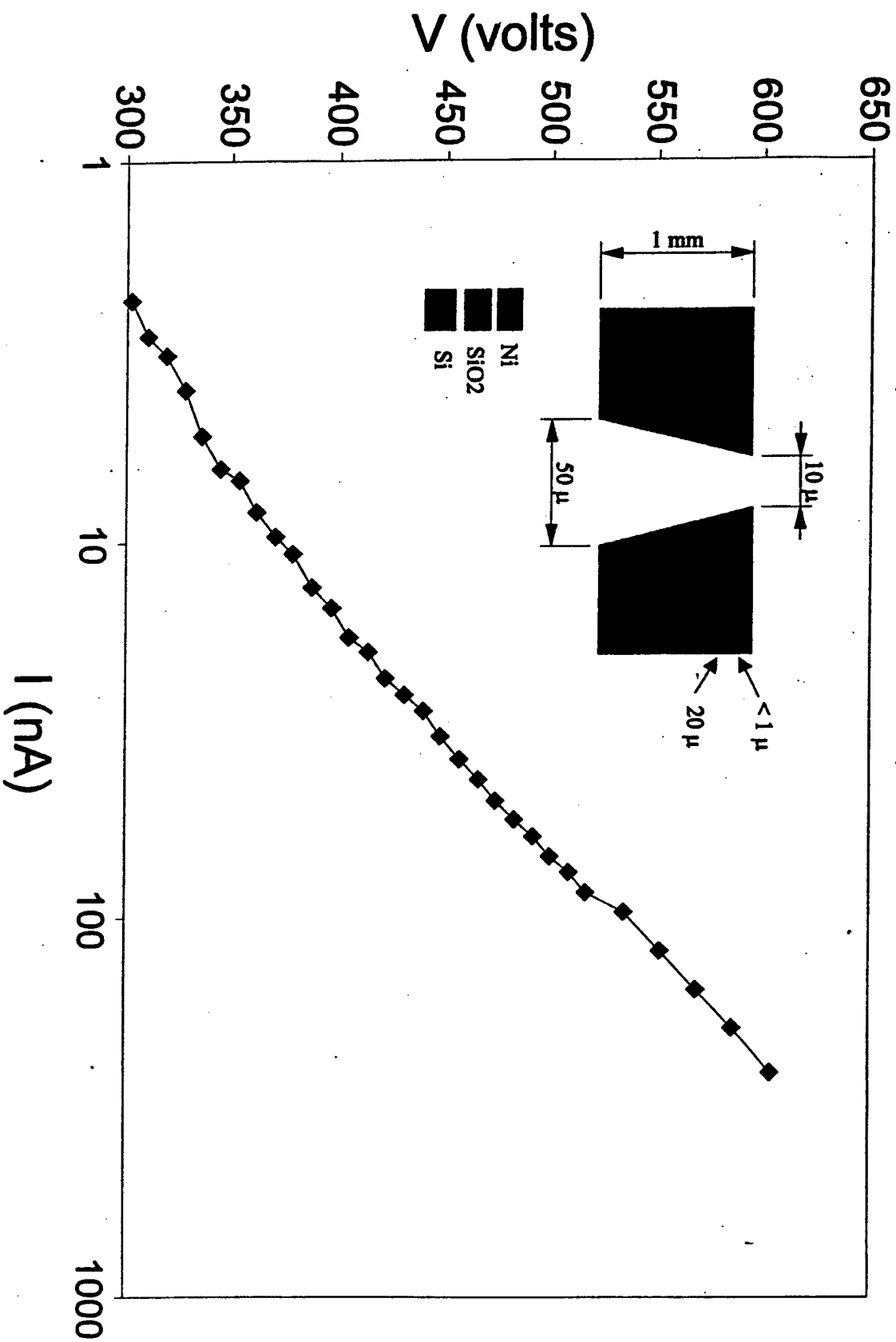
## Final Report for AFOSR Grant No. F49620-99-1-0106

In January of last year, the AFOSR (through the DOD DURIP Program), provided funding for equipment to fabricate microdischarge devices and arrays. With this funding, we have purchased several items, the most important of which is a Ti:sapphire regenerative amplifier that has been coupled to an existing Ti:sapphire oscillator system in our laboratory to provide ~100 fs pulses with energies up to 1 mJ. The amplifier arrived late in 1999 and we have already used this system for a number of experiments, but primarily for micromachining microdischarge cavities in metal/SiO<sub>2</sub>/Si and metal/polyimide/Cu structures. With this system, we were able to produce the smallest diameter microdischarge (~10 μm) fabricated to date. The V-I characteristic for a Si/SiO<sub>2</sub>/Ni device is shown in Fig. 1. Because of the growing importance of wall effects as the diameter of the microdischarge is decreased, the differential resistivity of the discharge is both positive and as large as ~500 kΩ. The specific power loading available with such a small device is also unprecedented. To date, we have measured values approaching 1 MW-cm<sup>-3</sup>! The excellent beam quality (near diffraction-limited) and pulse energy now available with this laser system now make it possible to attain instantaneous intensities above 10<sup>12</sup> W-cm<sup>-2</sup>. This is more than ample to ablate materials by multiphoton processes, thus enabling us to micromachine a wide variety of materials.

Our goal, however, is to fabricate still smaller structures for the purpose of examining photonic bandgap and QED effects. Specifically, as the dimensions of the microdischarge approach 1 μm and beyond, we expect to be able to "shape" the visible emission spectrum emanating from the discharge. To this end, the DURIP grant also provided funding for a compound VUV lens designed to image ArF laser (193 nm) radiation transmitted by a mask onto the surface to be micromachined. This very expensive lens (> \$14K) has been purchased and delivered and is capable of producing features below 5 μm in size. We are now in the process of combining this lens with other optics and an excimer laser in our laboratory to yield a laser micromachining station designed for micromachining primarily Si, metal films and polymers. It is expected that this facility will be completed this summer and will be immediately applied to the fabrication of microdischarge arrays. We are especially interested in the optical and electrical properties of large arrays of microdischarges. The scaling of power consumption and light output with the size of the array as well as exploring means to phase-lock the emission from the microdischarges are important issues that we intend to explore.

In summary, we are very grateful for the DURIP grant provided by AFOSR. It has made possible the purchase of laser and optical equipment that is enabling us to fabricate microdischarge devices having properties that are both fascinating and unprecedented. Because of the experimental results obtained thus far, we are submitting several patent disclosures to the University and the Air Force this Spring.

# 10 Micron Si/SiO<sub>2</sub>/Ni Device



**Fig. 1.** V-I characteristic for a 10  $\mu$ m diameter cylindrical microdischarge device micromachined with the Ti:sapphire laser system provided by DURIP funding. This device consists of a Si cathode, SiO<sub>2</sub> dielectric, and Ni anode.

